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13. ABSTRACT *(Maximum 200 words)*

The work reported here consisted of the fabrication and characterization of Si nano- and micro-structures useful for electronic and optical applications. The fabrications were all done in an *ultrahigh vacuum chamber (UHV)*, and the characterization was accomplished by using air and UHV scanning tunneling microscopy (STM), atomic force microscopy (AFM), infrared (IR) spectra, high resolution transmission electron microscpy (HRTEM), scanning electron microscopy (SEM) and optical microscopy.

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FINAL REPORT TO THE ARO NANOLITHOGRAPHY OF SEMICONDUCTOR STRUCTURES USING SCANNING PROBE MICROSCOPY

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1 Abstract

The work reported here consisted of the fabrication and characterization of Si nano- and micro-structures useful for electronic and optical applications. The fabrications were all done in an *ultrahigh vacuum chamber (UHV)*, and the characterization was accomplished by using air and UHV scanning tunneling microscopy (STM), atomic force microscopy (AFM), infrared (IR) spectra, high resolution transmission electron microscpy (HRTEM), scanning electron microscopy (SEM) and optical microscopy.

2 Fabrication of SiC films

The first system investigated consisted of fullerenes adsorbed on clean Si(111) and Si(100) reconstructed surfaces, as a function of fullerene layer thickness, temperature of deposition and annealing, and a combination of deposition of fullerenes and additional Si atoms. It was found that by holding a Si substrate at an elevated temperature while bombarding it with fullerenes, one can grow SiC films. IR and HRTEM were used to verify that the films indeed consisted of SiC. We are currently looking for methods to optimize this novel method that utilizes fullerenes as the carbon source. The results have been published in Surf. Sci. Lett. **311** L731 (1994), Surf. Sci. **318**, 74 (1994), Surf. Sci. (in print, 1995), Surf. Sci. (in print, 1995), Phys. Rev. B **49**, 7612 (1994), Phys. Rev. B **49**, 7612 (1994), J. Vac. Sci. Technol. B **12**, 1947 (1994), and J. Vac. Sci. Technol. B **12**, 1947 (1994), Electr. Lett. **30**, 1007 (1994), and McGraw Hill *Federal Technology Report*, October 27, (1994).

3 Fabrication of patterned SiC films

We exploited the fact that fullerenes do not adsorb on SiO_2, even at elevated temperatures, while they decompose and form SiC when incident on a bare Si surface.

Therefore, we obtained SiO_2 patterned Si wafers, heated them to around 800°C, and bombarded them with fullerenes. The samples were removed from the UHV chamber, characterized, rinsed in HF and characterized again. The results demonstrated that one can use this method to obtain patterned SiC films. The results, that demosntrated that one can obtain patterned SiC films, will appear in Nanotechnology (in print, 1995).

4 Dynamics of photoexcited charge carriers

We have demonstrated that the STM can be operated on a nsec time scale using, for example, the beat of the longitudinal modes of a HeNe laser at the tip-semiconductor junction. We are currently developing a similar method that employs fast laser diodes, and plan on characterizing the lifetime of charge carriers, on and around nanostructures, with nm and nsec resolutions. This work appeared in Appl. Phys. Lett. **64**, 256 (1994), Optics and Photonics News, December (1994), and McGraw-Hill (in print 1995).

5 Note

Part of this work appeared in *The Update*, a quarterly newsletter that describes curent technologies that have evolved from the ballistic Missile Defense Organization (BMDO)-funded projects.